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(54) A security fence for intrusion detection

(57) The fence comprises a combination of optical transmitters, optical fibers and optical receivers, which indicates damages or stresses to the fence when an intrusion is attempted. The fence 10 comprises a knitted optical wire structure 13 under tension between upper and lower tension wires 11, 12, the optical fibers being connected on the one hand to optical light transmitters 16 and on the other hand to optical light receivers 18, means being provided for detecting any substantial change in the light signal passing through the optical fibers.

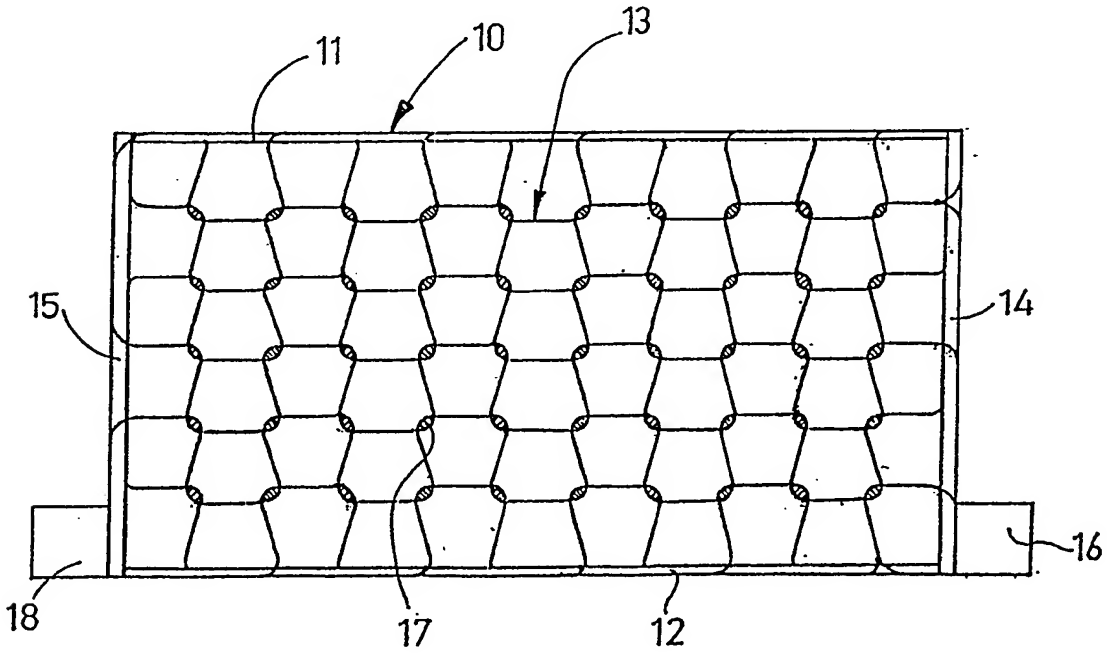

Fig.1

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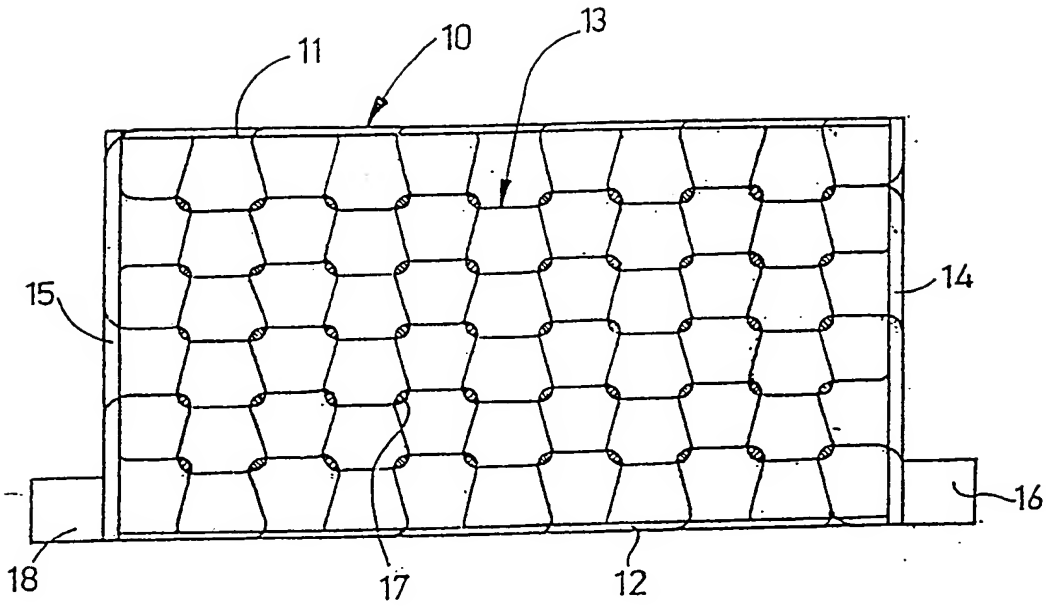

Fig.1

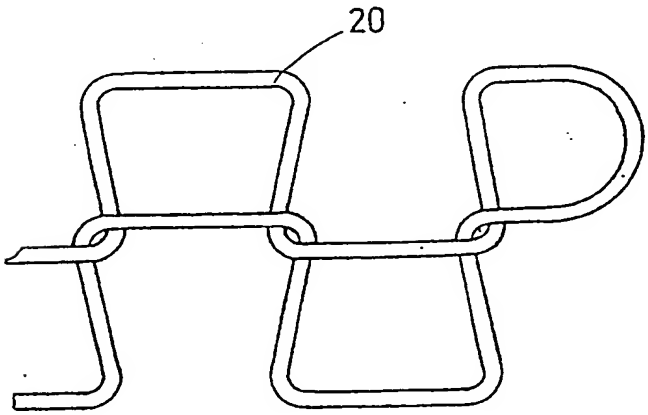

Fig.2

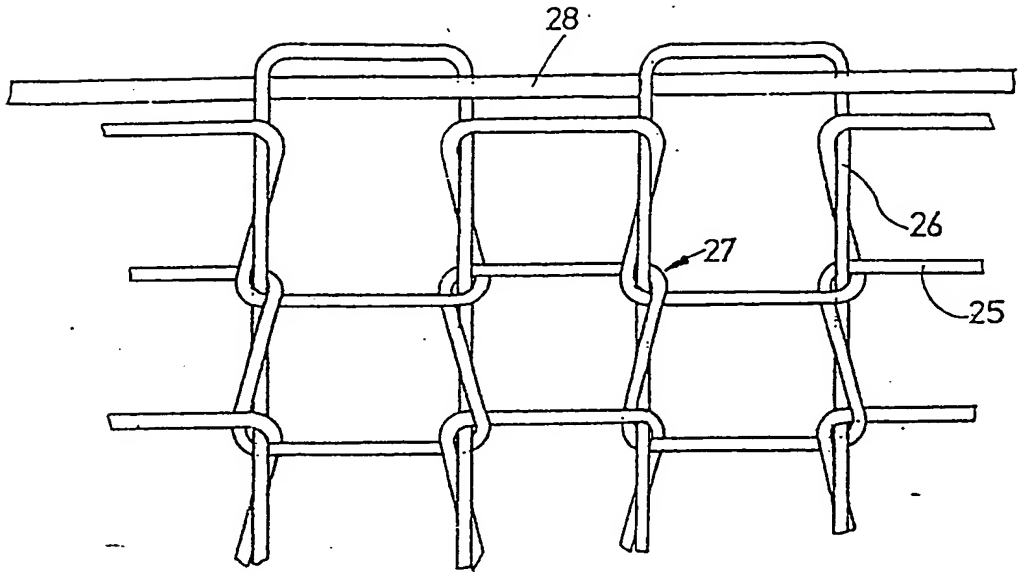

Fig.4

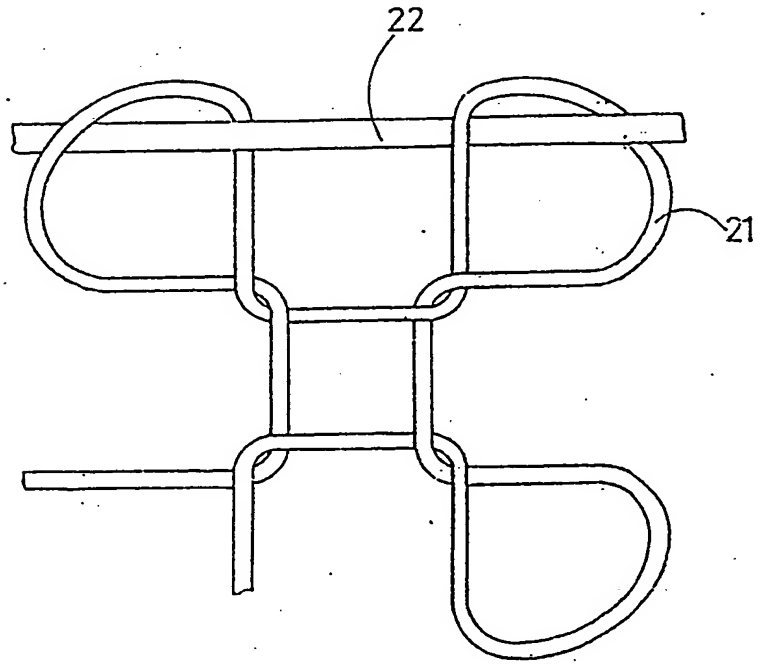

Fig.3

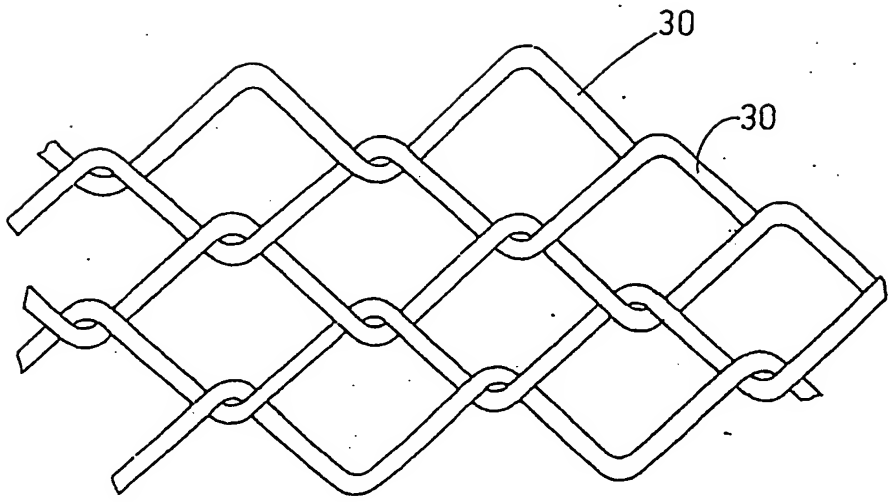

Fig.5

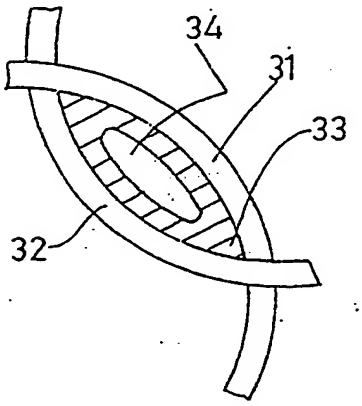

Fig.6.

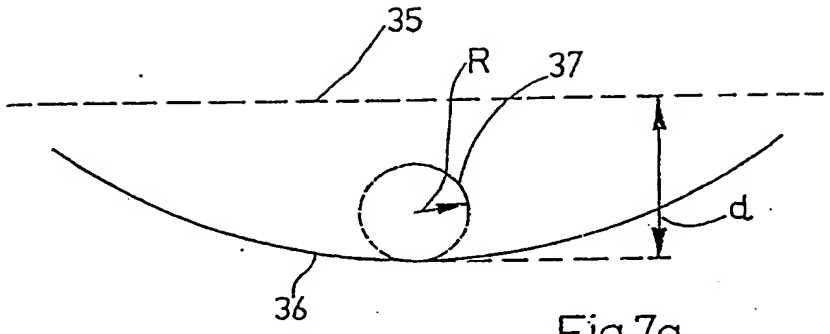

Fig.7a

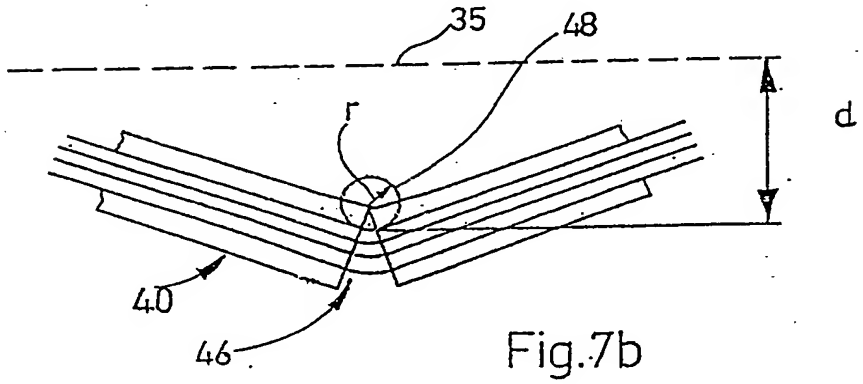

Fig.7b

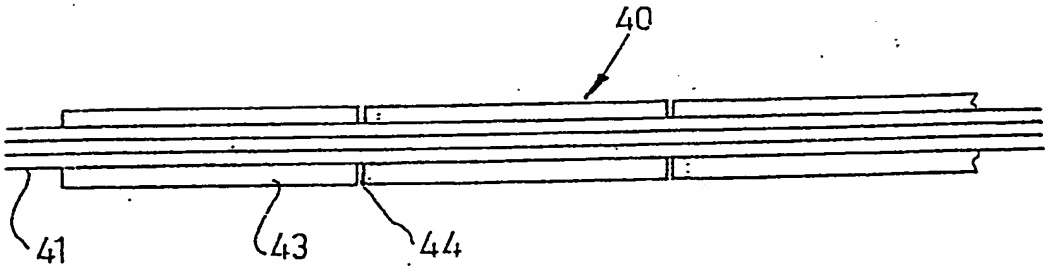

Fig.8

SECURITY FENCE

Field of the Invention

This invention relates to security fences embodying optical fibers, associated with optical transmitters and optical receivers, for signaling damages and stresses to the fence due to intrusion attempts, and to optical fiber products, usable in such fences, that are reactive to deformations to reduce light transmission therethrough.

Background of the Invention

Many intrusion detection barriers based on the use of optical fibers have been described in the prior art. In one type of such barriers, a sensor wire comprising optical fibers is stretched horizontally under tension between posts and is connected at one to an optical transmitter and at the other end to an optical receiver. Any attempt to climb over the fence results in changes of tension and possibly in damage to the sensor wire, and therefore in a change in the intensity of the light transmitted through it, which is sensed by the optical receiver, and activates an alarm.

A security fence comprising optical fibres is described in U.S. Patent 4,777.476. It comprises a multiplicity of hollow rigid bar elements and an optical fibre extending through some of the bar elements.

Predetermined bending of the optical fibre is provided in response to bending of some of the rigid bar elements by a given amount. An optical fibre support is disposed within each of the bar elements containing the optical fibre and arranged so as not to be displaced in response to bending of the corresponding rigid bar element up to a given amount. Such a structure however requires the use of hollow rigid bars, is not adapted to standard fences and is suited only to special applications, and further, is highly expensive.

Another type of a known security fence, described in European Patent 49,979, a mesh structure is provided, comprising an upper and a lower horizontal wire and transverse wires attached to them and disposed at a slant, to cross one another. All the wires are made of or comprise optical fibers. The various optical fibers are connected at their jointing points by means of connecting members which prevent relative displacement of said fibers and are sufficiently positive to ensure damage to the optical fibres when a certain load is applied to the mesh. Each fiber is connected to an optical transmitter and an optical receiver, so that its rupture will cause interruption of light transmission between the two and activate an alarm. Such a wire fence requires a multiplicity of optical circuits, each consisting of an optical transmitter, an optical receiver, and the fiber connecting them, which constitutes a disadvantage. Furthermore, it does not provide full protection against an intrusion, because an intruder may carefully cut through the connecting members placed at the joints between optical fibers, along a

plane substantially parallel to the plane of the fence, and thus free the optical wires from the mutual, rigid connection on which the operation of the fence depends; and it is sensitive to false alarms caused e.g. by animals pushing against the fence.

Another drawback of the known security fences based on optical fibers, is that they will not respond to sound an alarm unless the fibres have been cut or deformed to a degree which requires that a very high load be placed on them. If the fibre is not cut but deformed, the transmission of light therethrough will not completely cease, but will be reduced; however, a reduction sufficient to cause the system to respond will only be produced beyond a high deformation threshold. For this reason it has suggested in the prior art, to provide the fence with auxiliary devices, such as the rigid joints of the cited European Patent, which will cause damage to the fibre and sharply reduce the light transmission through them. However, the need for such auxiliary devices is a drawback, and further, they can be cut and neutralized, as noted hereinbefore.

It is an object of the invention to provide a security fence, which serves as an intrusion detection barrier, which will be free of the drawbacks of the barriers of the prior art, and specifically, will provide security against any attempt either to pass over it or to cut through it.

It is another object of the invention to provide such a security fence which includes a minimum of optical transmitter and receiver devices,

and is therefore simpler and more economical than the previously known ones.

It is a further object of the invention to provide optical fibres which respond to relatively light loads placed upon them by reducing the light transmission to an extent sufficient to cause an alarm to be given, without the need of external, auxiliary devices.

It is a still further object of the invention to provide such a fence which causes an alarm to be given whenever it is cut at one place at any point thereof.

It is a still further object of the invention to provide such a fence that is extremely simple from the structural viewpoint both as to the optical elements which are comprised in it and to the other elements and devices required for its installation and operation.

Other purposes of the invention will appear as the description proceeds.

Summary of the Invention

The invention provides a security fence which is characterized in that it comprises a knitted optical wire structure mounted under tension between upper and lower tension wires. Preferably at least one of said upper and lower tension wires is, or, more preferably both of them are,

optical wires. By "optical wires" is meant in this description and in the claims, wires which comprise or are of made of optical fibers, in any desired number and arrangement, whereby to provide a channel for light transmission, and provided with coatings, sheaths or supporting structures of any desired materials and kinds. The optical wires, forming the active components of the optical security fence, are connected to light transmitters and light receivers and these in turn are connected, through control devices, to alarm systems, whereby interruption or reduction below a certain threshold of the light transmission through an optical wire is sensed by a light receiver and results in an alarm being given. Said light transmitters and light receivers, control devices and alarm systems and their their structural and functional connections are conventional elements, present in existing optical security fences, so that they need not be described.

The knitted wire structure may have any desired length, and is made of a single wire or of more than one wire, as is known in the knitting art, and it may comprise a plurality of component structures, intertwined or combined in any suitable way, each of which comprises a single wire or a plurality thereof. Each single wire is associated with an optical transmitter and an optical receiver, so that if the wire is cut or badly damaged, the light transmission is interrupted or sharply reduced and an alarm is activated.

The invention further comprises an optical wire, useful in security fences, comprising an optical fibre component, preferably having a length that is a multiple of that of the optical wire, e.g. constituted by a plurality of optical fibres connected in series or by a single fibre forming a plurality of parallel branches along the wire, and a plurality of segmental, relatively rigid sheaths enclosing said fibres, disposed along the wire and adjacent to, optionally abutting, each other, so as to permit the wire to bend and stretch in correspondence to and to concentrate its deformations in said intervals, whereby to to render the wire more reactive to deformation by enhancing the reduction in the light transmission therethrough for a given overall deformation thereof.

Description of the Drawings

In the drawings:

Fig. 1 is a schematic, vertical view of a segment of a security fence according to an embodiment of the invention;

Fig. 2 is a schematic view of a fragment of a knitted structure, according to an embodiment of the invention, which structure, for purposes of illustration, is shown in a relatively loose condition and not under tension as it would be when in use;

Figs. 3, 4 and 5 are similar fragmentary views of knitted structures according to other embodiments of the invention;

Fig. 6 is a detail of the overlapping of two loops of a knitted fence according to another embodiment of the invention;

Figs. 7a and 7b illustrate the comparative behavior of a conventional optical wire and a wire according to an aspect of the invention; and

Fig. 8 illustrates an optical wire according to an embodiment of the invention.

Detailed Description of Preferred Embodiments

With reference now to Fig. 1, numeral 10 generally indicates a section of a security fence according to the invention, which can be of any desired dimensions. The section of the fence comprises an upper tension wire 11 and a lower tension wire 12 which, in this embodiment, are also optical wires. 14 and 15 indicate two posts which, together with the tension wires 11 and 12, constitute a parallelogram which forms the frame for a knitted, optical wire structure 13, to which said structure is connected under tension in both the vertical and the horizontal direction. Control boxes 16 and 18 contain all the necessary auxiliary equipment, which is conventional per se, including light transmitters, light receivers and a control device for the alarm system. Each optical

wire component is associated with a light transmitter and a light receiver, with which it constitutes an optical circuit. Thus the control boxes 16 and 18 will contain light transmitters and receivers for the tension wires 11 and 12, and for the wire or wires which constitute the knitted structure 13. All the said elements contained in the control boxes, being conventional, need not be described. In this embodiment, the knitted structure nodes, viz. the overlaps 17 between adjacent optical wire loops in knitted structure 13, are provided with curvature limiting means, such as will be described with reference to Fig. 6, which means however can be omitted in other embodiments of the invention.

The knitted structure 13 may be of any type that is known in the knitted art. It may be of the types known as warp-knit or weft-knit or of the net type. Figures 2 to 5 illustrate some possible, non-limitative example of such structures. In Fig. 2 a portion of a warp-knit structure, conventional per se, is shown, which is composed of a single wire 20.

In Fig. 3 a somewhat different, knitted structure, also conventional per se, made of a single wire 21, shown in its connection with an upper tension wire 22, is illustrated.

Fig. 4 shows a portion of a knitted structure composed of two wires, a first wire 25 which is knitted in a way similar to that shown in Fig. 2 and a second wire 26, which passes through interlocking loops of wire 25 at the structure nodes 27, and is also connected to an upper tension wire

28. Both in Fig. 3 and Fig. 4 it is understood that the connection to the lower tension wire would be similar to that shown with respect to the upper tension wire. It is also understood that the knitted structure will be connected in like manner or at any rate in any convenient manner to the posts which laterally limit each fence section.

Fig. 5 shows a portion of a knitted structure which is of the net type, and which can be made of a single wire or a plurality of wires, generally indicated at 30, and will be connected to the upper and lower tension wires and to the posts in the same way as the other knitted structures.

Since the various structures illustrated are under tension when installed and in operation, although they are shown in loose condition in the drawings, for purposes of illustration, marked bending may be produced in the optical wires at the points where the various loops overlap and interconnect. This may create excessive deformation of the optical wires with consequent reduction of the light transmission, which is undesirable and may even create false alarms. For this purpose, the curvature of the wires at the points where the various loops overlap is preferably limited in a way as illustrated in Fig. 6. Therein, the overlap of two loops 31-32 is illustrated at an enlarged scale, and a curvature limiting or protective element 33 is inserted between the two overlapping loop wires, said element 33 having two surfaces abutting the wire at the points belonging to the two overlapping loops 31 and 32, to limit the curvature which the wire will acquire at those points. The limiting

element may be of any kind, material or structure desired, and may be hollow, as shown at 34, or massive, or two or more limiting elements may be used instead of one. All that is required is that rigid, curvature limiting surfaces be provided in abutting relationship with the portions of the wire that are curved around each other in the overlap between mutually engaging loops.

According to another aspect of the invention, a novel optical wire structure is provided which is more sensitive to loads than the optical wires of the prior art. This novel wire is intended to be used in a straight, taught configuration, particularly as the upper tension wire in a fence such as illustrated in Fig. 1, but also as a tension wire, isolated or not, in any security installation, to react and activate an alarm not only when it is cut, but also whenever an intruder attempts to climb over it.

Figs. 7a and 7b illustrate the behavior of said novel optical wire. In Fig. 7a, a conventional wire is shown, which is intended to be in the straight configuration, illustrated by the broken line 35, e.g. when it is used as upper tension wire in fence comprising a network of optical wires. An attempt to climb over such a wire will give rise to a vertical load or to a load having a vertical component, and the wire will bend as indicated in Fig. 7a and will assume the configuration 36 illustrated in a full line. It is seen that the deflection of the wire is that indicated by "d" and constitutes a measure of the load placed thereon. When the deflected

yarn has assumed the curved configuration 36, it will have a curvature that is ordinarily at a maximum at the point of greatest deflection. The radius of curvature will be "R", and will be the radius of the circle shown in broken line at 37 in Fig. 7a. Bending of an optical fiber results in reducing light transmission, but before a system comprising the fibre can react in any way, and in particular, before an alarm can be given, the said reduction must reach a certain threshold, which corresponds to a certain radius of curvature, which can be called the maximum reactive radius. Let us assume that the maximum reactive radius is smaller than the radius "R" of circle 37: if so, the reduction of the light transmission through the bent optical fiber 36 will not be large enough for the system to react, and no alarm will be given.

Now, according to an aspect of the invention, the optical wire is provided with a succession of segmental coverings or sheaths, as illustrated in Fig. 8. In this latter, numeral 40 generally indicates the optical wire according to this embodiment of the invention. This comprises optical fibers 41 and segmental sheaths 43, arranged in longitudinal succession about the optical fibers. The segments are preferably in mutually abutting relationship, but small intervals could be left between them, if desired, as shown at 44 in the drawing. The segmental sheaths are made of a relatively rigid material, viz. material that is substantially rigid with respect to the optical fibers and which can be of any kind, but is conveniently a plastic or metal. Preferably the length of the segments is comprised between 6 and 20 cm. the diameter thereof is comprised

between 4 and 15 mm. In order to increase the sensitivity of the system, it is desirable to use an optical fiber component the length of which is a multiple of the length of the optical wire. This may be done by using a plurality of optical fibres 41, optically connected in any suitable way at the ends of the wire, e.g. in correspondence of the posts between which the fence is disposed, to form a continuous optical path for the transmission of light therethrough. Alternatively, one may use a single, continuous optical fibre, bent back at the ends of the wire to form a number of parallel branches along the length of the wire (in which case numeral 41 designates each of said branches), care being taken that the radius of the bent portions be greater than the maximum reactive radius hereinbefore defined. Since all the fibres, or fibre branches, extend in parallel relation along the wire, they will all be bent by the same angle and similarly stretched when the wire is bent. A reduction of the light transmission will occur in each fibre or branch at the bent and stretched zone and an overall reduction, that is a multiple of the reduction occurring in each fibre or branch, will thus be produced. In this way the sensitivity of the system will be greatly increased.

The behavior of the optical wire according to the invention is illustrated in Fig. 7b. The initial, straight position thereon is once again indicated in broken lines by numeral 35 and the wire is generally indicated in its deflected position at 40'. It will be seen that the deflection of the wire is the same as in Fig. 7a, and therefore the load applied to the wire will substantially be the same. However, the yarn according to the invention

will not bend at all in correspondence to the sheath segments. These will rotate, as shown in the drawing, so that their edges which are on the side of the concavity of the bent wire - generally the upper edges, as in the drawing - will remain in contact and their opposite edges will draw away from one another. Consequently, the optical fibre will be stretched in the zones in which the edges of any two adjacent segments are no longer in contact and will also bend in said zones, as shown at 46 in Fig. 7b. The radius of curvature "r" of the optical fibers under those conditions will be the radius of the circle 48, and it is seen that, the deflection being equal, "r" is much smaller than "R". Consequently, while "R" may be larger than the maximum reactive radius, "r" may be smaller, and thus the wire according to the invention will cause the security system to react while a conventional optical wire would not do so. Additionally, the optical fibres are stretched at 46, and this deformation also affects the light transmission, whereby the reactivity of the system is further increased.

In a preferred embodiment of the invention, the security fence comprises an optical wire according to the embodiment of Fig. 8 as upper tension wire, which guards against intrusion by climbing over the fence, while the knitted structure and the lower tension wire are made of ordinary optical fibre structures, which can be relied upon to react to complete interruption of the light transmission, viz. to cutting. Complete safety and high sensitivity are thus achieved at a minimal cost.

Whereas the knitted optical wire structure is stated to be mounted under tension between upper and lower tension wires, it is to be understood that the knitted optical wire structure can be tensioned between tension wires which are in a vertical position or at any desired angle.

While certain embodiments of the invention have been described by way of illustration, it will be understood that the invention can be carried into practice by skilled persons with many modifications, variations and adaptations and by the use of equivalent means, without departing from its spirit and from the scope of the claims.

CLAIMS

1 - Security fence, characterized in that it comprises a knitted optical wire structure mounted under tension between upper and lower tension wires.

2 - Security fence according to claim 1, wherein at least one of said upper and lower tension wires is an optical wire.

3 - Security fence according to claim 1, wherein the optical wires are connected to light transmitters and light receivers and these in turn are connected, through control devices, to alarm systems, whereby interruption or reduction below a certain threshold of the light transmission through an optical wire is sensed by a light receiver and results in an alarm being given.

4 - Security fence according to claim 1, wherein the knitted wire structure comprises a single optical wire, which is associated with an optical transmitter and an optical receiver.

5 - Security fence according to claim 1, wherein the knitted wire structure comprises a plurality of optical wires, each of which is associated with an optical transmitter and an optical receiver.

6 - Security fence according to claim 1, comprising at least one section which comprises an upper tension wire, a lower tension wire and two posts which, together with the tension wires, constitute a parallelogram which forms the frame for a knitted, optical wire structure 13, to which said structure is connected under tension in both the vertical and the horizontal direction.

7 - Security fence according to claim 1, comprising comprising relatively rigid curvature limiting elements inserted between portions of optical wire overlapping at the nodes of the knitted structure.

8 - Optical wire, useful in security fences, comprising an optical fibre component having a length that is a multiple of the length of the wire, and a plurality of segmental, relatively rigid sheaths enclosing said fibre component, disposed along the wire adjacent to each other.

9 - Optical wire according to claim 8, wherein the fibre component comprises a plurality of optical fibres optically connected in series, whereby to form a single, continuous light transmission channel.

10 - Security fence according to claim 6, wherein the upper tension wire is an optical wire according to claim 8 or 9.

11 - Security fence constructed substantially as hereinbefore described with reference to the accompanying drawings.

17

Patents Act 1977
Examiner's report to the Comptroller under section 17 (The Search Report)

Application number
GB 9215715.5

Relevant Technical fields

(i) UK Cl (Edition K) G4N (NSBA)

(ii) Int Cl (Edition 5) G08B 13/12

Search Examiner
D L SUMMERHAYES

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search
18 SEPTEMBER 1992

Documents considered relevant following a search in respect of claims 1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2038060 A (STC) see whole document	1,3,4,5
X	EP 0049979 A2 (PILKINGTON) see whole document, particularly page 4 lines 4-5; page 13 line 23 - page 14, line 7, figure 5	1-7

Category	Identity of document and relevant passages	Rele .t to claim(s)

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P: Document published on or after the declared priority date but before the filing date of the present application.

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